

WHAT IS CLAIMED IS:

1. A nonvolatile semiconductor memory device,
comprising:

5 (a) first and second semiconductor regions formed in
a semiconductor substrate;

(b) first and second gate electrodes located near said
semiconductor substrate between said first and second
semiconductor regions;

10 (c) a first insulator film formed between said first
gate electrode and said semiconductor substrate; and

(d) a second insulator film formed between said second
gate electrode and said semiconductor substrate;

(e) wherein said second insulator film comprises a
15 potential barrier film formed on said semiconductor
substrate and a charge trapping film formed on said
potential barrier film; and

wherein said charge trapping film comprises a silicon
oxynitride film and a third insulator film in which the sum
20 of the energy between a vacuum level and a conduction band
of said third insulator film and a band gap of said third
insulator film is smaller than that of said silicon
oxynitride film; and

wherein the product of a charge trap density and a film thickness of said silicon oxynitride film is larger than that of said third insulator film.

5 2. The nonvolatile semiconductor memory device according to claim 1,

 wherein said third insulator film is a silicon nitride film.

10 3. The nonvolatile semiconductor memory device according to claim 1,

 wherein said third insulator film is another silicon oxynitride film having an oxygen concentration lower than that of said silicon oxynitride film.

15 4. The nonvolatile semiconductor memory device according to claim 1,

 wherein said third insulator film is formed between said silicon oxynitride film and said potential barrier
20 film.

 5. The nonvolatile semiconductor memory device according to claim 1,

 wherein said third insulator film is formed on said
25 silicon oxynitride film.

6. The nonvolatile semiconductor memory device
according to claim 1,

wherein said charge trapping film includes a fourth
5 insulator film in which the sum of the energy between the
vacuum level and the conduction band of said fourth film and
the band gap of said fourth film is smaller than that of said
silicon oxynitride film; and

wherein said silicon oxynitride film is formed between
10 said third and fourth insulator films.

7. The nonvolatile semiconductor memory device
according to claim 1,

wherein said device further includes a fourth
15 insulator film formed on said charge trapping film; and

wherein, when said energy between said vacuum level and
said conduction band is smaller in said silicon oxynitride
film than in said fourth insulator film, said fourth
insulator film is 1 nm and under in thickness.

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8. The nonvolatile semiconductor memory device
according to claim 1,

wherein said silicon oxynitride film has a charge
trapping function and electrons trapped in said silicon

oxynitride film are ejected into said second gate electrode due to a potential applied to said second gate electrode.

9. The nonvolatile semiconductor memory device
5 according to claim 1,
wherein the condition $z = 0.314$ or greater is satisfied when said silicon oxynitride film is composed as $\text{Si}_x\text{O}_y\text{N}_z$ where $(x + y + z = 1)$.

10 10. The nonvolatile semiconductor memory device
according to claim 1,
wherein the condition $y = 0.3$ or less is satisfied when said silicon oxynitride film is assumed as $\text{Si}_x\text{O}_y\text{N}_z$ where $(x + y + z = 1)$.

15 11. The nonvolatile semiconductor memory device
according to claim 1,
wherein said silicon oxynitride film is over 10 nm to 30 nm in thickness.

20 12. The nonvolatile semiconductor memory device
according to claim 11,
wherein said silicon oxynitride film is over 12 nm to 20 nm in thickness.

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13. The nonvolatile semiconductor memory device according to claim 1,

wherein said silicon oxynitride film is a deposited film.

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14. The nonvolatile semiconductor memory device according to claim 1,

wherein said silicon oxynitride film is formed with silicon compounds, oxygen compounds, and nitrogen compounds or silicon compounds and other compounds including oxygen and nitrogen with use of a chemical vapor deposition method.

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15. The nonvolatile semiconductor memory device according to claim 1,

wherein said silicon oxynitride film is formed by depositing silicon in an oxidative atmosphere and in a nitriding atmosphere respectively.

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20 16. A nonvolatile semiconductor memory device, comprising:

(a) first and second semiconductor regions formed in a semiconductor substrate;

(b) first and second gate electrodes located by said semiconductor substrate between said first and second semiconductor regions;

(c) a first insulator film formed between said first gate electrode and said semiconductor substrate; and

(d) a second insulator film formed between said second gate electrode and said semiconductor substrate;

(e) wherein said second insulator film comprises a potential barrier film located on said semiconductor substrate and a silicon oxynitride film located on the potential barrier film wherein said second gate electrode is positioned on said silicon oxynitride film.

17. The nonvolatile semiconductor memory device according to claim 16,

wherein said silicon oxynitride film has a charge trapping function and electrons trapped in said silicon oxynitride film are ejected into said second gate electrode due to a potential applied to said second gate electrode.

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18. A nonvolatile semiconductor memory device, comprising:

(a) first and second semiconductor regions formed in a semiconductor substrate;

(b) first and second gate electrodes located by said semiconductor substrate between said first and second semiconductor regions;

(c) a first insulator film formed between said first
5 gate electrode and said semiconductor substrate; and

(d) a second insulator film formed between said second gate electrode and said semiconductor substrate;

(e) wherein said second insulator film comprises a first potential barrier film formed on said semiconductor
10 substrate, a silicon oxynitride film formed on said first potential barrier film, and a second potential barrier film formed on said silicon oxynitride film wherein said second potential barrier film is 1 nm or less in thickness.

15 19. The nonvolatile semiconductor memory device according to claim 18,

wherein said second potential barrier film is 0.5 nm or less in thickness.

20 20. The nonvolatile semiconductor memory device according to claim 18,

wherein said silicon oxynitride film has a charge trapping function and electrons trapped in said silicon oxynitride film are ejected into said second gate electrode
25 due to a potential applied to said second gate electrode.